Evaluation of 2,4-D Ester and Triclopyr Amine Against Waterlily and Spatterdock

by LeeAnn M. Glomski and Linda S. Nelson

PURPOSE: It has been speculated that herbicide drift from treated sites can negatively impact desirable floating vegetation and there are many scenarios where targeted submersed weeds and non-target floating plants grow in close proximity. This study was conducted to determine the effects of submersed applications of 2,4-D ester and triclopyr amine, used to control Eurasian watermilfoil (*Myriophyllum spicatum* L.), on waterlily (*Nymphaea odorata* Ait.) and spatterdock (*Nuphar lutea* (L.) Sm.).

BACKGROUND: Waterlily and spatterdock are two ecologically important shoreline plants in Midwestern lakes, providing valuable habitat for invertebrates, amphibians, fish, waterbirds, and aquatic mammals. The seeds are a food source for waterfowl and the rhizomes are eaten by muskrats, beaver, and porcupines (Borman et. al. 1997). Many Midwestern lakes, however, have been heavily infested with the non-native submersed plant Eurasian watermilfoil. Submersed applications of 2,4-D (ester and amine formulations) and triclopyr (amine formulation) are typically used to control Eurasian watermilfoil, and there is concern that off-site drift from these applications may cause un-intended damage to non-target, floating-leaved plant stands.

Both 2,4-D and triclopyr are auxin-type herbicides effective on dicotyledons (dicots). An advantage of using these products is that they are specific for dicots and do not impact native monocot species. The mode of action is believed to involve nucleic acid metabolism and cell wall plasticity. Both herbicides are thought to stimulate membrane-bound ATPase proton pumps, which acidify the cell wall. Lowering the apoplasmic pH increases the activity of enzymes involved in cell wall loosening, causing cells to elongate in an uncontrolled fashion. Triclopyr and 2,4-D also stimulate ethylene production, which can cause epinastic symptoms (downward bending/twisting of stem, petioles and leaves) typical of auxin-type herbicides. Both herbicides are rapidly translocated in plant tissues via the symplastic pathway (including the phloem) and accumulate in the meristematic regions. Degradation of both 2,4-D and triclopyr is via microbes and photolysis (Weed Science Society of America (WSSA) 2002).

Information in the literature regarding 2,4-D and triclopyr applications to control waterlily and spatterdock typically discuss foliar applications and the amine formulations of the products. Hanlon and Haller (1990, 1991) studied the effects of foliar applications of 2,4-D amine on spatterdock and found that rates up to 4.48 kg ha^{-1} did not kill plants. Initially spatterdock showed symptoms of chlorosis, epinasty, and reduced vigor, but long-term results showed no significant impact on leaf number or biomass. Langeland et al. (1993) reported that waterlily was sensitive to triclopyr; however, no details were given regarding application rates. No published information could be found on the effects of 2,4-D ester on either waterlily or spatterdock.

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MATERIALS AND METHODS: This study was conducted in an outdoor mesocosm system at the U.S. Army Engineer Research and Development Center, Lewisville Aquatic Ecosystem Research Facility (LAERF) located in Lewisville, TX. One spatterdock rhizome or one waterlily tuber was planted into 3.78-L pots filled with LAERF pond sediment amended with 3 g L^{-1} Osmocote (16-8-12). Plant propagules were obtained from Kester's Wild Game Food Nurseries, Inc. (Omro, WI). Three pots of each species were placed into forty, 760-L Rubbermaid® (Fairlawn, OH) tanks. Tanks were filled with alum-treated Lake Lewisville water to a depth of 50 cm and plants were allowed to grow for 48 days prior to treatment.

Treatment took place on July 12, 2006 and included: 0.25, 0.50, 1.00, 1.50 and 2.50 mg L^{-1} 2,4-D ester as Aquakleen® (Cerexagri-Nisso, King of Prussia, PA); 0.25, 0.50, 1.00 and 2.00 mg L^{-1} triclopyr amine as Renovate® 3 (SePRO Corporation, Carmel, IN); and an untreated control. Low rates of both products (0.25, 0.50 mg L^{-1}) represented drift from treated sites and higher rates represented rates typically used to control Eurasian watermilfoil. After 24 hr of exposure, all tanks were drained and refilled with untreated water to remove aqueous herbicide residues. Six weeks after treatment (WAT), all biomass (shoots and roots) was harvested and dried at 65 °C to a constant weight.

Treatments were randomly assigned to tanks and replicated four times. To meet assumptions of normality and equality of variances, the data were transformed with a rank procedure (PROC RANK NORMAL=BLOM) using the Statistical Analysis System (SAS Institute, Inc., Cary NC). Transformed data were subjected to analysis of variance procedures and means were separated using the Waller-Duncan *k*-ratio t-test at P=0.05 level of significance. Non-transformed data are presented.

RESULTS AND DISCUSSION: Within 1 DAT, all rates of 2,4-D ester and triclopyr amine caused waterlily leaves to curl. For spatterdock, only slight leaf curling was seen at the lower rates of each herbicide. Curling of spatterdock leaves and petioles was observed at higher rates but was not as severe as symptoms on the waterlilies. At 2 WAT, elongation and curling of the petioles was seen on both species. Symptoms such as leaf and petiole curling and petiole elongation are common to auxin-type herbicides such as 2,4-D and triclopyr (WSSA 2002). These symptoms are indicators of herbicide exposure and plant injury, but not of plant control. Yellowing of waterlily and spatterdock leaves was also seen at 2 WAT. Because yellow leaves eventually became necrotic, this symptom was an indicator of plant control.

At 6 WAT, only waterlilies treated with 1.50 and 2.50 mg L^{-1} 2,4-D ester had significantly less shoot and root biomass compared to the untreated control (Figures 1 and 2). Reductions in biomass ranged from 51 to 90 percent for shoots and 69 to 83 percent for roots. Low rates of 2,4-D ester (0.25 and 0.50 mg L^{-1}) and all rates of triclopyr amine did not cause a significant decrease in either shoot or root biomass. Spatterdock shoot biomass was only significantly less than the control at the higher rates of 1.50 and 2.50 mg L^{-1} 2,4-D ester and 2.00 mg L^{-1} triclopyr amine (Figure 3). Average reduction in shoot biomass for these treatments was 48 percent. There were no significant differences among the treatments for spatterdock roots (Figure 4).

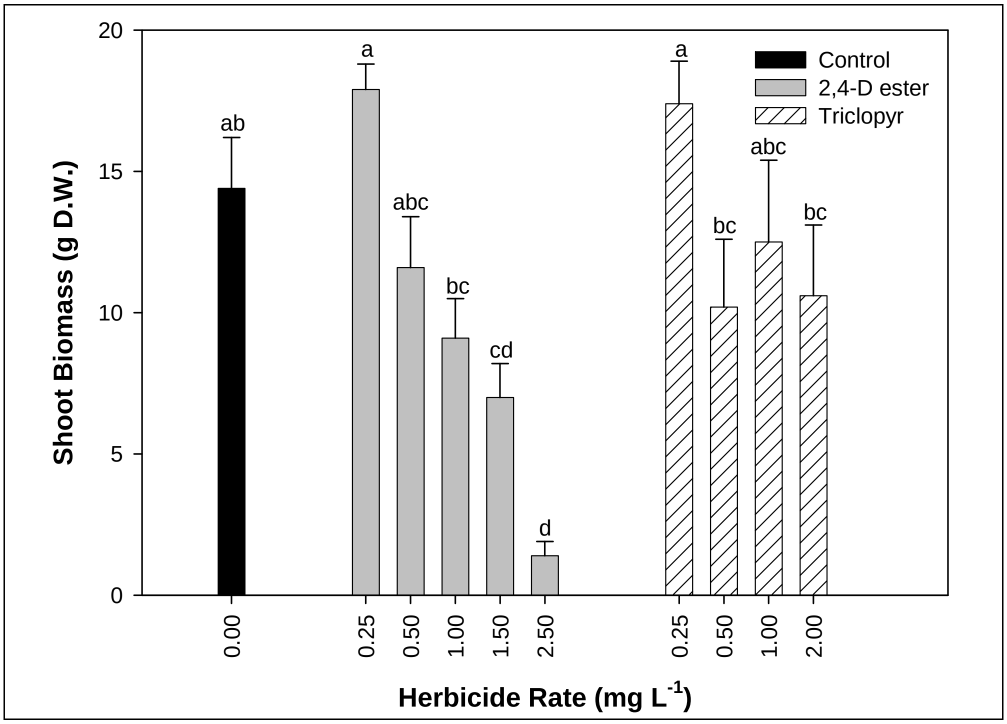

Figure 1. Mean (± SE) dry weight (D.W.) of waterlily shoot biomass collected 6 weeks after treatment. Bars sharing the same letter do not significantly differ from each other.

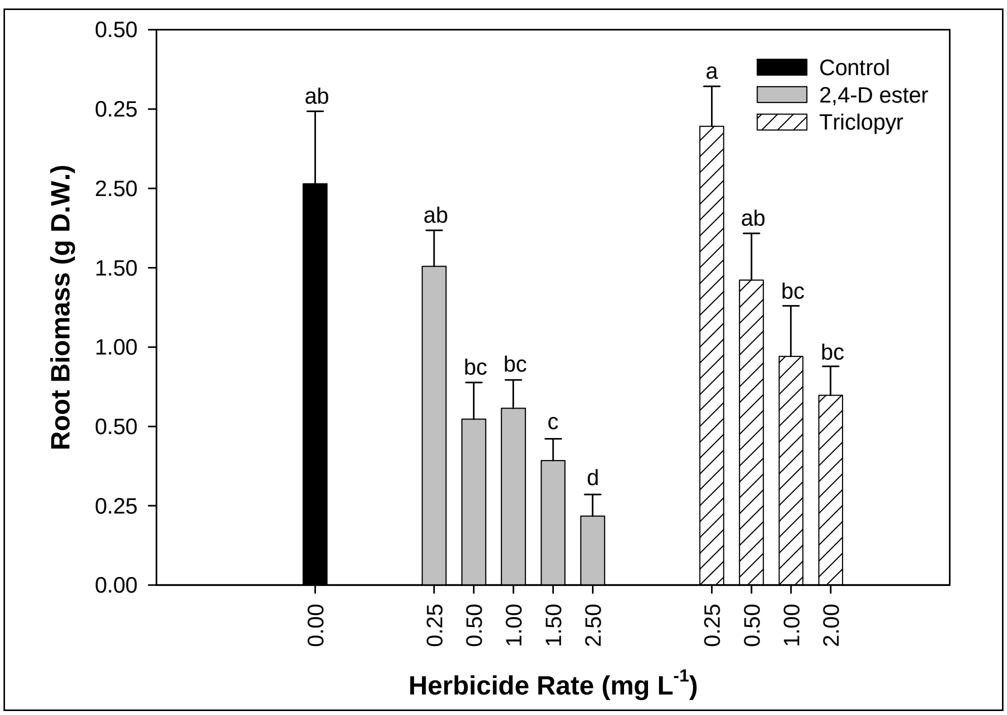

Figure 2. Mean (± SE) dry weight (D.W.) of waterlily root biomass collected 6 weeks after treatment WAT. Bars sharing the same letter do not significantly differ from each other.

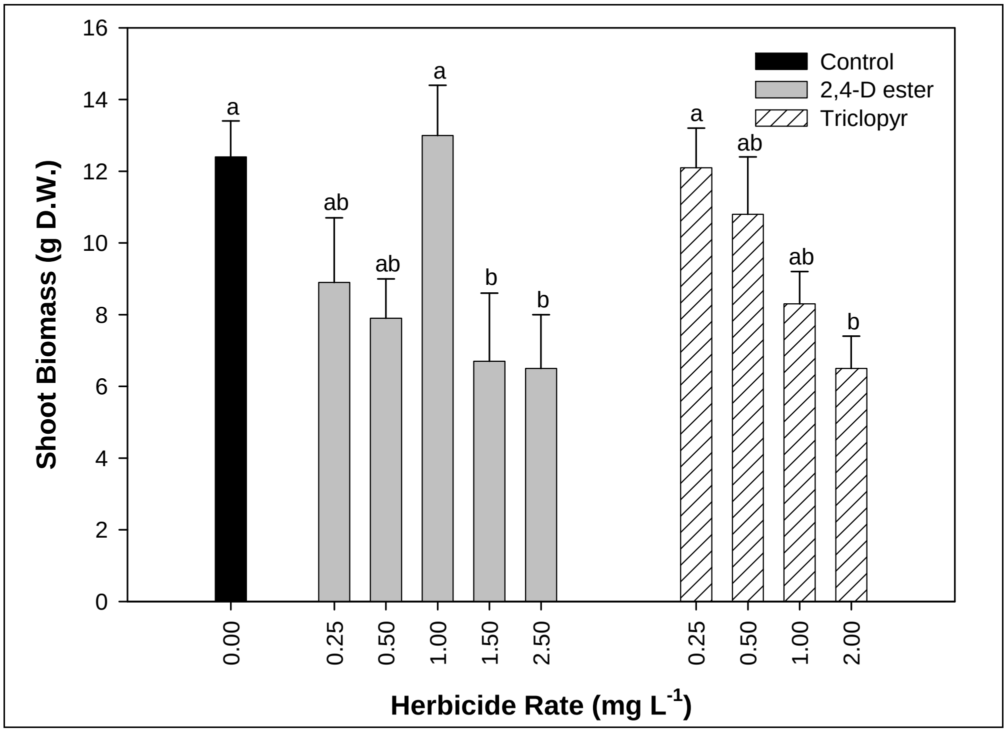

Figure 3. Mean (± SE) dry weight (D.W.) of spatterdock shoot biomass collected 6 weeks after treatment. Bars sharing the same letter do not significantly differ from each other.

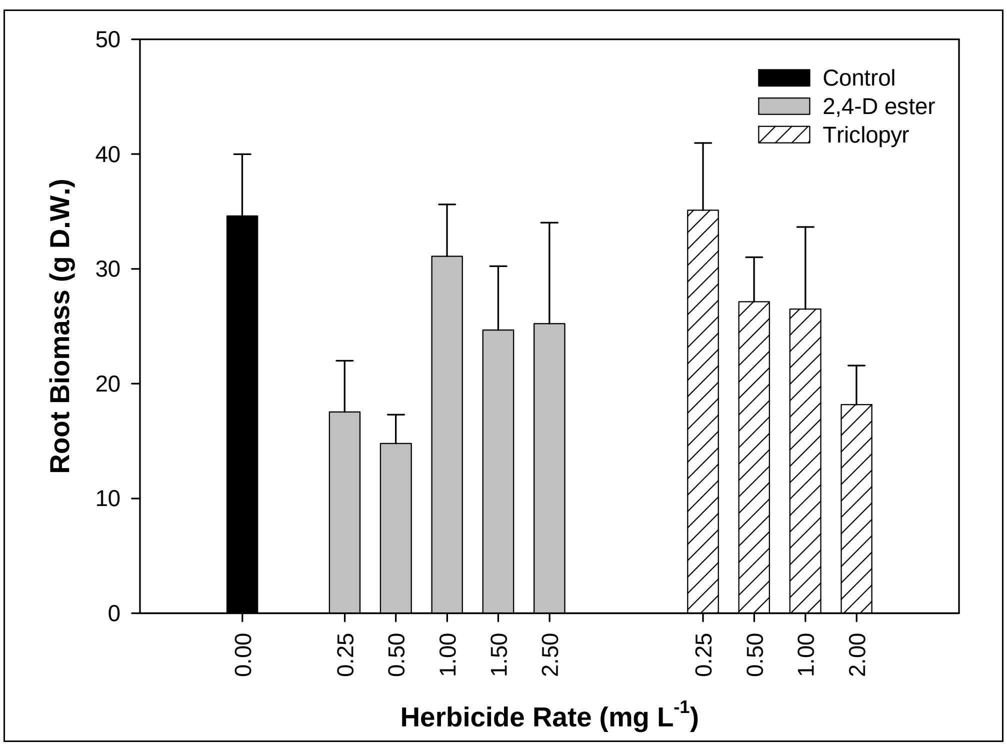

Figure 4. Mean (± SE) dry weight (D.W.) of spatterdock root biomass collected 6 weeks after treatment. No significant differences were found among the treatments.

The results of this study showed that 2,4-D ester rates used to control Eurasian watermilfoil (2.00 mg L^{-1}) could cause substantial injury to waterlily, whereas a 1.25 mg L^{-1} triclopyr amine treatment would not. Typical milfoil treatments of 2.00 mg L^{-1} 2,4-D ester and 1.25 mg L^{-1} triclopyr amine would cause initial injury to spatterdock; however, plants are likely to recover. Low rates of both herbicides would also cause some initial injury to waterlily and spatterdock, but observations from this study indicate that plants will not suffer long-term damage.

In areas where waterlily and spatterdock are intermixed with Eurasian watermilfoil, lowering the rate of triclopyr amine by 0.50 to 1.00 mg L^{-1} will reduce injury to waterlily and spatterdock but still provide good control of the Eurasian watermilfoil (Netherland and Getsinger 1992). Lowering the rate of 2,4-D ester would reduce injury to waterlily and spatterdock; however, a longer exposure period may be necessary to achieve good Eurasian watermilfoil control (Elliston and Steward 1972, Green and Westerdahl 1990). Results from this initial study also indicate that triclopyr may be less phytotoxic to waterlily and spatterdock than the 2,4-D ester; however, further evaluation is necessary.

FUTURE WORK: The current study will be repeated in 2008 to verify initial results and will include impacts on hardstem bulrush (*Schoenoplectus acutus* (Muhl. ex Bigelow) A.& D. Löve), another valuable plant species in Midwestern lakes. Additional research should examine longer exposures to low rates of both herbicides. In the current study, waterlily and spatterdock exposed to low rates for 24 hr recovered; however, it needs to be determined whether plants exposed longer than 24 hr would recover as well.

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